# HYDRAULIC POWER DEVELOPMENT

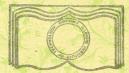
ON

EAST CANADA CREEK, NEW YORK

G. W. BUCK W. J. DEVENEY G. D. LETTERMANN

ARMOUR INSTITUTE OF TECHNOLOGY
1910

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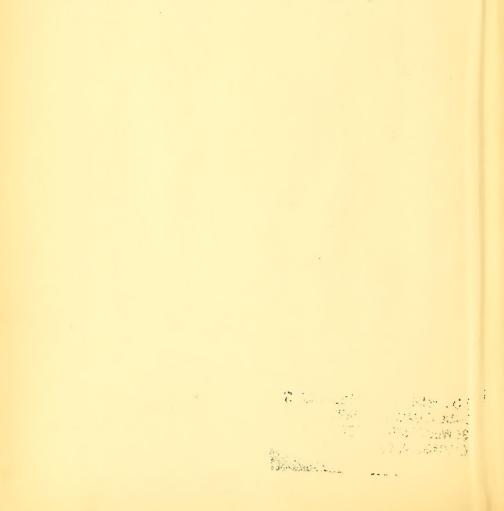


AT 175 Buck, G. W. Proposed hydraulic power development on East Canada

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## PROPOSED HYDRAULIC POWER DEVELOPMENT.

ON

EAST CANADA CREEK.

AT

INGHAM MILLS, NEW YORK.

ATHESIS

Presented By

S. Warner Buck.

Horge D. Letterman

To The

PRESIDENT AND FACULTY

OF

ARMOUR INSTITUTE OF TECHNOLOGY

For the Degree of

Bachelor of Science In Civil Engineering

Having Completed The Prescribed Course

In

Civil Engineering.

ILLINOIS INSTITUTE OF TECHNOLOGY
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Natural water powers have long held an important place among the sources of energy available for industrial purposes. Within the past few years, the progress made in the methods for converting mechanical into electrical energy, and the increase in the distance to which the latter can be economically transmitted, have led to the utilization of many water powers. The advantages to any community of cheap and reliable power are so great, that a steady growth of this kind is to be expected. Apart from manufacturers of all kinds, the purely municipal purposes of lighting and electric traction will of themselves, absorb a considerable amount of power.

The investigation of any water power project should include a careful study of all available data relating to the topographical and meteorological factors that effect the water supply and that obtain on the drainage area of the stream on which the proposed hydraulic power development is projected. The present condition of these factors is readily obtainable by careful observation and surveys, but the most difficult and yet the most important information needed for the correct understanding of the project, is the variations from the present conditions that have occurred in the past and that are therefore liable to re-occur in the future.

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On the correct intrepretation of the available data the success of the project, or at least the economy of the installation, depends, especially if, as is usually the case, it is desired to develop the plant to its economical maximum.

The state of New York is richly endowed with natural advantages favorable to a full utilization of its vast water power resources. On its many rivers, especially those springing from the prolific water producing region of the Adirondacks, there are many advantageous sites for creating new developments, and for increasing by artificial storage the capacity of existing power plants.

Ingham Mills is about five miles from Little Falls, New York and is reached by a branch of the New York Central Railroad.

The situation of Ingham Mills is exceptionally advantageous for a hydraulic power plant, being in the center of a fairly well developed manufacturing district. Within a radius of thirty miles are Gloversville, Johnstown, Fonda and Canajoharie. The present use of electric current for lighting, traction and manufacturing purposes within this radius is great and the constantly increasing demand insures a large market.

The object of this thesis is the profitable development

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The state of New York is richly endowed with natural adventages favorable to a full utilisation of its vast water yower resources. On its many rivers, supecially times apringing from the prolific water producing region of the Adirondacks, there are many advantageous sites for creating new developments, and for increasing by artificial storage the capacity of emisting power plants.

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The object of this thooks is the profitable certae great

of the available water power of East Canada creek at Ingham Mills for the purpose of partially supplying this demand, and it is with the preliminary investigation, design and construction of such project that we shall confine ourselves.

## HYDRAULIC CONDITIONS AND DEVELOPMENT.

The requisites of a reservoir site are numerous, among which may be mentioned the following:-

- 1. There must be an available water supply sufficient to fill the basin.
  - 2. There must be a basin to hold this supply.
  - 3. There must be a good dam site.
- 4. There must be suitable materials from which to construct a dam.
- 5. The foundation must be able to satisfactorily sustain the dam.
- 6. There must be available lands upon which to put the water.
  - 7. The entire project must be on a commercial basis.

A comprehensive and detailed study of existing topographical maps and hydrographic data on the East Canada creek in the Mohawk system indicated promising opportunities for power development and storage.

East Canada creek is the second important tributary of

of the available water cover of East Ceneda orack at Enghan Mills for the purpose of workladly supplying this donesd, and it is with the preliminary investigation, desirn and orac attraction of such prof. or that we shall confine ourselver.

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  - 6. There wast be swillable leads agon waich to put the water.
  - 7. The ently project and be on a commercial basis.

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the Mohawk. This creek rises in the south western part of Hamilton County, and flows southerly between Herkimer and Fulton Counties, joining the Mohawk at East creek, about seven miles from Little Falls. Its drainage area above Ingham Mills comprising approximately two hundred and seventy three square miles, contains about thirty small lakes and ponds and numerous swamps and marshes in the region of the head waters. A considerable part of the basin is timber covered. The underlying rock is granitic gneiss in the upper portion of the basin, with limestone in some places. Heavy accumulations of snow occur during the winter.

The principal tributary of East Canada creek is Big

Sprite creek, which is the outlet of the East Canada Lakes.

The distance from the East Canada Lake outlet to its junction with East Canada creek, is about nine miles. In the first four miles there is a fall of three hundred and ninety feet. The remaining five miles to its mouth, has a fall of two hundred and forty-five feet.

The second tributary of East Canada creek is Spruce creek, which enters it one mile above Dolgeville and drains an area of fifty square miles. The total length from its source in the Eaton Mill pond to its mouth, is about nine miles; the total fall in this distance being approximately five hundred and fifty feet. Just below the Eaton Mill

the Mohask. This oresk riper in the south western pare of Wamilton County, and flows southarly between Nerkiner and Fulton Counties, joining the Foliask at Mast oresk, about seven wiles from Little Falls. Its drainage area above Ingham Mills comprising approximately two huncred and seventy three square miles, contains about thirty small lakes and pouds and numerous swamps and marches in the region of the head waters. A considerable part of the basin is timber coverad. The underlying rock is granitic gnoiss in the upper portion of the basin, with limestons in seme places. Heavy accumulations of snow occur doring the winter.

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The second tributary of last Canean creek is Sprace creek, which enters it one mile above Polyerilie and drains an area of fifey aquare wiles. The betth length from the source in the laten Will pand to its matter, is about nine siles; the total fail in this distance being appreniation fire bandred and fifty feet. That below the Paten will

pond there is a fall of one hundred and eighty feet in two
thousand feet. At Salisbury Center, Spruce creek falls eightyfive feet in about nine hundred feet. A number of water
power privileges are developed at this point. There is a
total of twelve small dams on Spruce creek giving an
aggregate fall of about one hundred and eighty feet.

The mean annual rainfall on the East Canada water-shed above Ingham Mills for the past ten years, as disclosed by studies of the United States Weather Bureau reports, is 40 inches.

The conditions on which the proposed development is based were obtained from the various water supply papers of the United States Geological Surve y for the past ten years (1899-1909 inclusive), containing the maximum and minimum daily and monthly discharges of the stream at Dolgeville about three miles up stream from Ingham Mills. At this point the discharge of the stream over the dam of the Herkimer County Light and Power Company, is computed from a discharge curve based on United States Geological Survey experiments.

About a mile above Ingham Mills, Gillette creek having a drainage area of approximately seventeen square miles, flows into East Canada creek. The drainage area of the East Canada creek above Dolgeville is two hundred and fifty-six square miles; thus the total area drained by the stream above

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five feet in about hims huncred feet. A number of water

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About a mile above Ingham Mills, dillette ereck having a drainegs area of approximately seventuen equals willow, flows into Mast Caneda ereck. The drainage area of the Rast Caneda ereck above believille is two hence or cad fifter six aquare miles; thus the total area drained by the energy above

Ingham Mills is two hundred and seventy-three sq uare miles.

The data as to the discharge at Ingham Mills, were determined by multiplying the various discharge measurements obtained at Dolgeville by the constant  $\frac{273}{256} = 1.06$ ; 273 being the total drainage area in square miles above Ingham Mills and 256 being the area above Dolgeville. This factor took into account the additional discharge due to Gillette creek. From these data mean monthly discharge curves were plotted. A curve was also plotted showing the daily discharge of the stream for the year 1906, which was a year of relatively high flood.

The flow of the stream at Ingham Mills varies from a maximum of 3280 second feet to a minimum of 90 second feet.

A dam will be constructed at Stewart Landing near the head of Big Sprite creek by means of which a large service reservoir of 500,000,000 gallons capacity will be created. The function of this reservoir is to augment considerably the minimum discharge of the stream at Ingham Mills.

By constructing a dam across the valley where the stream is about ninety feet wide, a head of one hundred and twenty-five feet can be utilized. It was concluded that using a flow of two hundred and fifty second feet for twenty-four hours, or six hundred second feet for a period of ten hours the maximum power of the stream could be developed throughout the entire year without the necessity of an emergency steam

Ingham Mills is two hundred and seventy-three sq ware miles.

The date as to the discharge at In ham Wills, were determined by smitiplying the various discharge measurements ebtained at Delgoville by the constant  $\frac{273}{255} = 1.06$ ; 273 being the total drainage area in square miles above Ingham Wills and 256 being the area above Dolgeville. This factor took into account the additional discharge due to dillette creek. From these date scan social excharge ourses war glotted. A curve was also plotted seering the daily discharge of the stream for the year 1806, which was a year of

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plant.

The available power was determined as follows:

Let Q = discharge in second feet.

H = available head.

W = weight of a cubic foot of water

E = efficiency of water wheels

then Horse Power =  $\frac{Q \times H \times W \times E}{550}$ 

or

$$H.P. = \frac{600 \times 125 \times 62.5 \times .85}{550} = 7200$$

The proposed development consists of a gravity dam, one hundred and twenty-five feet in height. The main conduit to be a pipe line with an internal diameter of twelve feet. The total length is eleven hundred feet of riveted steel pipe provided with a surge tank fifty eight feet high and forty feet in diameter. The function of the surge tank is to relieve the pipe line of excessive pressures due to a sudden closing of the gates in the water wheels, following a quick drop in the demand for power and also to maintain pressures and speed regulation in the station when sudden demands are made for water. The top of the surge tank rises to twenty-five feet above high water level above dam. From the surge tank there will be three riveted steel pipes, each six feet in diameter and four hundred feet in length, leading directly to the power house. The total hydrostatic head from the flow line of the reservoir to centers of receivers, will be one hundred and twenty-five feet.

The available power was determined as follows: Let Q= discharge in second fest. H= available hase.

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then Morse Power = 250

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The location chosen combines the advantages of a fairly short dam with a comparatively high position of bed rock. The cross section is shown on Plate 3.

The dam will be built of solid concrete masonry and founded on bed rock. Its length measured on the crest is five hundred and ten feet. It will be one hundred and twenty-three feet above the present river bed and its foundation will extend two feet lower, making a total height of one hundred and twenty-five feet above bed rock with a batter of 1 in 12.5. Along the west bank of the stream at the site of the dam, there is a pocket about ten feet deep and five feet wide, caused by the erosive action of the stream at this point. In order to eliminate an unnecessary amount of rock excavation, this pocket will be filled with concrete.

At each end of the dam concrete core-walls, having a batter of 1 in 20 and placed two feet in rock extend into the adjoining sides of the valley in such a manner as to form

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A tops readler to the tension the stadia noted, was added of the valier to the immediate vicinity of inches Wills. The removal location of the dem sas determined by the tensional location of the dem sas determined considerable study to fix its exact size. A major of test jits sere such to bed rock in the strengthy meses of eculorism construction.

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to each end of the improvers occurating a battle of its 20 and placed the feat in speciment late the speciment of the value and a second of the speciment of th

a perfectly safe seal and thus prevent the water from escaping around the ends of the structure.

A spillway for carrying off flood water will be constructed on the east end of the dam. The length of this waste-way is two hundred and sixty feet and its crest is ten feet lower than that of the retaining section. It is twenty-four feet in height, having a vertical up-stream face and an ogee down-stream face. Concrete of a 1-2-4 mixture will be used in constructing both the dam and spillway.

An intake for supplying the conduit will be placed near the west end of the dam on the up-stream side. At this intake the water is controlled by a twelve foot circular sluice gate. This gate has a non-rising stem, which passes through an operating stand on top of the dam. The stand is geared so that it may be operated by hand. Screens inclined at an angle of approximately sixty degrees to the horizontal, are placed at the entrance of the intake to protect the intake pipe. Provision is made for repairing the sluice gate by means of emergency stop logs. Access can be had to the sluice gate chamber by an iron ladder projectiong from the concrete wall and extending from the top to the pit of the chamber. Drainage of the chamber is provided by a twelve inch drain pipe, extending under the intake pipe and through to the down-stream side of the dam.

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A spillway for carrying off flood water will be conwaster-var is two hundred and sinty foot and its creat is ten
feet lower than that of the relating acction. It is twentyfour feet in height, having a wertical ny-stream face and an
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An interest for supplying the conduct will be placed near the west end of the interest to mean on the measurement of this interest in conterplied for a sective feet eironiar aluice gate. This gate has a non-rising stand, which passes through an specific stand on top of the dam. The stand is geared as that it may be operated by sand. Servens inclined at an that it may be operated by sand. Servens inclined at an area of inproximately slatty degrees to incherical, are placed at the entrance of the interest to protect the interest place of the interest of the interest of the same of sacregary stop lays. Access can be bed to the slade gate by slade gate one the observe at you and it on the to, to the interest and extending from the to, to the it is at the shander. Erathery of the dam that it is intake the interest and insent the interest of the day, the interest of the day.

The dam is designed purely as a gravity structure, and the usual standards of strength and stability are followed. The water was assumed to extend from the top of the dam to bed rock, but was not supposed to penetrate beneath and exert an upward pressure.

The profile as shown on Plate 3 is divided into six sections by horizontal joints. The centers of gravity of courses 1 to 6 are found in the usual manner, the vertical section of each course being assumed to form a trapezoid.

The retaining section was designed as follows:
Reservoir Empty: The line of pressure was determined in the following manner:- The center of gravity of sections 1 and 2 are joined by a line and the center of gravity of these two combined sections found, as shown on Plate 3. A line is drawn vertically downward from the center of gravity of sections 1 and 2. Where this vertical line intersects the line bb is one point in the line of pressure. In a similar manner the points where this line intersects the other joints are found. When the reservoir is empty, the only forces acting on the dam, are the weights of the different courses 1 to 6, each being applied at the center of gravity of the respective course.

Reservoir Full: The line of resultant pressure was determined as follows: - The pressure of the water acts at a point equal to one third the height from the base of section 2. This distance

The dam is dealgned purely as a gravity at a tractive, and the accal standards of strength and stability are itellowed. The weter were accounted to extend from the top of the due to bed reck, but was not augmented to prostrate beneata and exert

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The retaining station was equipment for itselfs the in the Reservair impty: Westine of presents was delicited in the fallowing standard. The contest of gravity of sections i and bear joined by a lim, and the contest of gravity of sections i and the contest of gravity of view the combined sections found, as shown an Flate? A lime in drawn vertically command from the contest of gravity of a setions I and L. Where this vertical lime interacts are line and the gravity of line by is one, care in the line of present, the admitted scanner the point theoretical in the line of present, in the admitted and for reservate in the contest the order that our case are into the day, are the weights of the adifferent course. The angles the care of the care of the respective of the respective of the care and are the care of the care of the respective.

Reserveir Polit Who line of semilar a process are definite of as Politower- The process of the same semilar as a semilar time set from the height of semilar of semilar semilar and a more

is laid off to scale on the line drawn vertically downward through the center of gravity of sections 1 and 2. From this point a perpendicular line equal in length to the water pressure, is drawn. A line equal in length to the weight of the masonry, is drawn perpendicular to the line of water pressure. Where the resultant of the line representing the water pressure and the weight of masonry respectively, intersects the joint bb is one point in the line of resultant pressure. Similarly, the points where this resultant intersects the other joints are found.

The resultant of all joints is kept within the middle third, so that there are no tensile stresses.

The factors of safety are the following: As to Overturning:- The moment of the forces, which resist over-turning when taken about the down-stream edge of the dam at any elevation are more than twice as great as the moment of over-turning at the same point.

As to Sliding:- A coefficient of friction of .85 in the concrete masonry was assumed. Conservative engineering practice shows that this factor is considered amply safe in case of a concrete dam in which there will be no joints properly speaking, but on the contrary, considerable cohesive strength

is laid off to scale on the line dram, vertically downward through the center of gravity of sections I and R. From this point a partendiorier line actual in Longth to the water pressure, is dram partendionier to the largen act weight of the manney, is dram partendionier to the line of water pressure. Where the resultant of the line representing the mater pressure and the weight of mascury respectively, intersects the joint lab is one point in the line of resultant pressure. Similarly, the point where this resultant pressure. Similarly, the points where this resultant pressure. Similarly, the points where this resultant acts are found.

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The factors of cufety are the following: As to dwert training: The moment of the faces, thich resist ever-turning when taken about the deam-street edge of the can at any clev. - tion are more than twice we prost as the masses of or returning at the same point.

As to Sliding:- A coefficient of friction of ... in the correcte account was assumed. Consumative curindering practice shows that the feeter is construred us... coefs in the secret of a construred will be no feater property. The construent will be no feater property.

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Spillway Section: The curve on the down-stream side was determined by plotting the parabolic curve, using the equation of the parabola

$$X^2 = 2 P Y. (1)$$

where 2 P by experiment was found to be equal to 1.98 H; the height of water flowing over the crest of the spillway being assumed as five feet, then  $H = \frac{H}{8} + 5$ 

· H = 5.710.

substituting the above values in (1)

Therefore:  $X^2 = (1.98 \times 5.71) \text{ Y.}$ 

The line of resultant pressure of the spillway section, the profile of which is shown on Plate4 was determined in the same manner as that followed in the design of the retaining section.

In order to increase the height of the spillway section during low water, so as to dispose of a higher head than would be otherwise possible at a moment when such increase of head is most opportune, flash boards were designed so as to give way when the water reaches the desired elevation. These flash boards are held in place by "Wayne" irom pins fitted in pipe sleeves in the concrete. When a fiber stress of 69500 pounds per square inch is reached, the pins fail.

Spillmar Section: The curre on the down-rirence side was determined by plotting the parabolic curre, using the equation of the garabola

$$X^{\varepsilon} + Z P Y.$$
 (1)

: H = 5.710.

substituting the above values in (1)
Therefore: X<sup>2</sup> = (1.98 x 5.71) Y.

The line of recultant pressure of the spillary soction, the grafile of which is shown on Plates was determined in the sure manner as that followed in the design of the retaining

In order to increase the height of the spilling acction during low water, so as to dispose of a higher coad than world be otherwise possible at a moment when such increase of heid is most opportune, flesh beards were designed so as to give way when the water peaches the desired elevation. Thuse flesh beards are held in place by "Wayne" from place fitted in pieceste. When a fiber atreas of 65000 jounds sleetes inch is reacued, the pins fath.

#### CALCULATIONS.

RETAINING SECTION:-

Area of section 1:  $\frac{14}{2}[12+13.1] = 175.7$  sq. ft.

Area of section 2:  $\frac{11}{2}[13.1+18] = 171$  sq. ft.

Weight of sections 1 and 2: [175.7 + 171] 150 = 520123 |bs/cu.ft.

Water pressure at 25 foot depth:  $\frac{wh^2}{2} = \frac{62.5 \times (25)^2}{2} = 19530 \text{ lbs/sq. ft.}$ 

Resultant water pressure: 56000 lbs. per square foot.

Area of section 3:  $\frac{25}{2}[18+34] = 650 \text{ sq. ft.}$ 

Weight of sections 1, 2 and 3: [175.7 + 171 + 650] 150 = 149513 lbs./w

Water pressure at 50 foot depth:  $\frac{62.5 \times \overline{50}^2}{2} = 83125$  /bs./sq.ff.

Resultant pressure: 170400 lbs. per square foot.

Area of section 4:  $\frac{25}{2} \left[ 34 + 52 \right] = /075$  sq. ft.

Weight of sections 1, 2, 3 and 4: 996.75 + 1075 = 31076 / bs / co.ff.

Water pressure at 75 foot depth:  $\frac{62.5 \times 75^2}{2} = 175780 / bs / sq. ff$ .

Resultant pressure: 357600 lbs. per square foot

Area of section 5:  $\frac{25}{2} [52 + 70] = 1525 \text{ sq. ff.}$ 

Weight of sections 1, 2, 3, 4 and 5: [207/.75 + 1525] 150 = 5395/3 /b

Water pressure 100 foot depth:  $\frac{62.5 \times 100^2}{2} = 3/2500$  lbs.  $\frac{59.6}{1}$ 

Resultant pressure: 623500 lbs. per square foot.

Area of section 6:  $\frac{25}{2} \left[ 70 + 88 \right] = 1975 \text{ sq. ft.}$ 

Weight of sections 1, 2, 3, 4, 5 and 6: 3596.75 + 1975 / 50 = 835763

Water pressure 125 foot depth:  $\frac{62.5 \times \overline{125}^2}{2} = 488280 \text{ lbs / sq. ff.}$ Total resultant pressure: 966700 lbs. per square foot.

HENDER OF DESI

Area of section 1: Upress. - 1787 sq m

Area of section 2: 4/12/4/2=121 og 1:

Weight of sections 1 and 2:  $1757 + 177 150 = 520123 195/auth Water presence up up foot depth: <math>\frac{wh^2}{2} = \frac{65.5 \times 100^2}{2} = 13530 1/s/auth$ 

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Road tank writer presented the loss pirtle that

Area of acetion 3: of inter and aces square

Weight of sections 1, 2 and 3: [7574 17/4650] 150 . 1-19573/had

Water pressure at 50 foot depth: 62.52 27125 162/sq 17.

Resultant prissure: 170400 lbs. per square foot

Area of saction 4: 4 [sass] -/ 075 spin

Weight of sections 1, 2, 3 and 4: [336.754.1075] 150-31076 103/10 Water pressure at 75 foot depth: 3658 15 105780 38/44 A.

Resultant pressure: 357600 lbs. por system foot

Area of section 5: 2 Servo = 1828 of M.

Weight of sections 1, 2, 2, 4 and 5: [conner tours] isom towers. Water pressure 100 foot depth: 62.222.22 and and and another pressure 100 foot depth:

THE REAL PROPERTY AND PERSONS ASSESSED.

Area of rection 6: 1 70+88 - 1975 Suff.

Weight of sections 1, 2, 3, 4, 6 and 6: Jeon Ch. St. uch & St.

Witer grassure 12. foot (opth: GER 1855 - 4 98282 May / . . / A

Total resultant pressure: 906/00 this per constituter fator

### RETAINING SECTION (concluded):-

Factor of safety against over-turning:

Factor of safety against sliding:

Assuming coefficient of friction of concrete on

rock as .85

$$p_1 = \frac{R}{l} = \frac{966700}{75.8} = 12753 \text{ lbs.}$$

$$p_2 = \frac{GRb}{l^2} = \frac{6\times 966700\times 10.8}{(75.8)^2} = 10902 \text{ lb.}$$

$$p_3 = 12753 - 10902 = 1851^{\#} \text{ min.}$$

$$p_4 + p_2 = 12753 + 10902 = 23655^{\#} \text{ min.}$$

### SPILIWAY SECTION: -

Area of section 1:  $9 \times 1.43 = 12.87$  sq. ft. Area of section 2:  $\frac{2}{3} \left[ 9 \times 10.08 \right] = 60.48$  sq. ft.

Area of section 3:  $\frac{15}{2}$  20.5+11.5 = 240 sq. ft.

Total weight of sections 1, 2 and 3:

[12.87+60.48+240] 150 = 47000 lbs. / cu ft.

Total water pressure:  $\frac{62.5 \times 24^2}{2} = 25600 \text{ /bs.} / \text{sq. ft.}$ 

Let h= height of section

d = depth of water on crest

Then point of application of water pressure is  $\frac{h+3d}{h+2d} \times \frac{h}{3}$  from the bottom of section.  $\frac{24+15}{24+10} \times 8 = 9.17'$ 

Total resultant pressure: 52200 lbs. per sq. ft.

Factor of safety against over-turning:

# 

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Hassalley Marcent 835:6: x .55 8 = 22.

Factor of safety against aliding:

Assuming coefficient of friction of concrete on

as. as moor

835783 x . 85 . . .

b, - 5, = 12 1153 - 10 202 - 1851 min. MARKET PARTIES AND A PROPERTY OF PERSONS ASSESSMENT ASSESSMENT ASSESSMENT ASSESSMENT ASSESSMENT ASSESSMENT ASS

+1 TO THE XALLY OF

Area of section 1:  $3 \times 1.43 = 12.87 \text{ sq. Pl}$ Area of section 2:  $\frac{2}{3} [3 \times 10.00] = 60.48 \text{ sq. Pl}$ 

Area of section 3: 4 76.5+11.5 = 240 54 ff.

Total weight of sections 1, 2 and 2: 12.87+50.48+340 180=47000 185/00 ft.

Total water process: 52 55 25 25000 185 1: 17:

Let he height of section

de dopth of water on creat

Then point of application of water pressure is  $\frac{2 \times 30}{1000} \times \frac{1}{1000}$ from the bottom of section. The 1/3 252317

Factor of salety mainst over-turning:

Presidency Marchet Amond 18. E

# SPILLWAY SECTION (concluded):-

Factor of safety against sliding:

Assuming coefficient of friction of concrete on

rock as .85

$$\beta_1 - \beta_2 = 2900 - 1788 = 1112 / bs. (minimum)$$

The second secon

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since Q = AV V= Q = /100 = /0.6

### PIPE-LINE

The water is delivered to the power house through a riveted steel pipe, twelve feet in diameter and eleven hundred feet long, and through two six foot pipes which act as penstocks for the turbines in the power house. The connection between the single large pipe and the two smaller ones is made by means of a surge tank forty feet in diameter and fifty-eight feet high, which is placed on a high spot about four hundred feet from the power house.

The intake of this twelve foot pipe is at elevation 640, the crest of the dam at 675, giving a head of thirty-five feet, and was designed to carry twelve hundred cubic feet of water per second.

Using the formula  $h = f \frac{l}{d} \times \frac{V^2}{2g}$ , where

h = loss of head

f = coefficient

1 = length

d = diameter

v = velocity

g = gravity

and assuming a 12 foot pipe

$$h = .01 \frac{1050}{12} \times \frac{112.36}{64.3}$$

therefore h = 1.53

Slope, 
$$S = \frac{h}{l} = \frac{1.53}{1050} = .00145$$

Then from

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The unter is delivered to the newer house through a rivele due redemnib ni fast oviews .amin feets betavin Jon folde sagig took ale out danced the . neet test head headen as remateche for the turbines in the power house. The reflace out off bus eric erret almais ent secrice neiteennoo ones is nade by means of a surge tank forty feet in at mo bear is a didn't feet high, which is riseed on a high spot shout four hundred feet from the power house.

The intake of this twelve foot pipe is at clovation 640, the crest of the dam at 672, giving a head of thirty-rive yest, and was designed to early twelve hundred cubic feet of water THE STREET, THE P.

Vains the formula h-fg x 20 , where

g - gravity

and ausuming a U2 foot pipe

STATE SHAPE

where c = constant

r = hydraulic mean radius: for full pipe  $r = \frac{d}{4}$ , since pipe must be designed for maximum.

Substituting values

$$v = 190 \sqrt{3} \times .00145$$

12.35 = feet per second.

This velocity is not too large because maximum amount of water will not be used and consequently the velocity will not reach this figure.

There fore use 12 foot pipe

Thickness of pipe:

Allowable tensile strength of pipe = 16000 lbs. per square inch
Head = 35 feet

Head (in feet) x .434 = lbs. per square inch

Then  $W \times \frac{d}{2} = t \times 16000$ ;

35 x .434 x 6 x 12 = t x 16000 x 12  

$$\therefore t = .054 = \frac{1}{16}$$

Allowing for water hammer, which occurs and also for stiffness of pipe use %inches.

Therefore Pipe Dimensions are as follows:-

Diameter:- 12 feet

Thickness:- 3/8 inches

Length of Plate: - 6 feet

wmere c = constant

r - hydraulic mean radius: for full pipa raif, since

state attitless

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12.50 ricet per second.

This velocity is not too large because marimum amount of water will not be used and consequently the velocity will not reach this figure.

There fore use 12 feet pipe.

Lacks to seasonist

Allowable tensile strength of pipe = 16000 lbs. per squert inch

Mond (in feet) x . 134 - 1bs. per square inch

Then W x dat x 16000;

Si m 00001 m J-Si m 8 m 464. m 48

1 to . 05.8 o /6"

Allowing for water banner, which occurs and also for stiffness of pipe use a inches.

Thursdaye Pips Dimonsions are as follows:-

forl di -: resensid

THE PERSON NAMED IN COLUMN 1 INC.

Length of Plote: - C feet

RIVETS :-

Rivets should be  $\frac{1}{4}$  x thickness of thickest plate +  $\frac{3}{16}$ : then  $\frac{5}{4} + \frac{3}{8} = \frac{15}{32} + \frac{6}{32} = \frac{21}{32}$ ; Therefore use  $\frac{3}{4}$  rivets.

The spacing should be not less than  $\frac{1}{2}$  x diameter +  $\frac{1}{2}$   $\frac{3}{2}$  x  $\frac{3}{4}$  =  $\frac{9}{8}$  x  $\frac{4}{8}$  =  $\frac{13}{8}$  =  $1\frac{5}{8}$ " Use 2".

The girth seams are lap jointed, single riveted and the longitudinal seams lap jointed, double riveted. Considering six foot section, the pressure is found to be

1094 x 6 x 12 = 78720 lbs.

Allowing 12000 lbs. for double shear, then  $\frac{78720}{/2000}=7^+$ ; therefore 8 rivets per foot will be used.

The diameters of adjacent 6 foot lengths vary by twice the thickness of the plate, forming inside and outside sections alternately, and angle irons 5"x 3" are placed at every other joint, thus strengthening the pipe between supports. The supports being concrete piers every 12 feet except through one section where they are placed every 10 feet. At this section the pipe is suspended 15 feet and the concrete piers are 20 feet high, reaching to the center line of the pipe. They are 2 feet thick and 16 feet wide.

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Hive to should held x thickness of thickness flat: by the should held  $\frac{2}{3}$ . Therefore use  $\frac{2}{3}$  rivets.

The specing should be not less than a dismeterable

1094 x 6 x 12 = 78720 12m

Allowing 12000 lbs. for double shear, then with the there is the trees are foot will be used.

The diameters of adjacent 6 foot lemith; very by twice the thickness of the plate, forming inside and outside sections alternately, and engls from the first placed at every other joins, thus strengthening the pipe between supports. The supports being concrete piers every 18 feet except through casesonion where they are placed every 10 feet. At this section the pipe is suspended 16 feet and the concrete piers are 20 feet bigh, reaching to the center line of the jipe. They are feet bight to the center line of the jipe. They are

The alignment of the pipe in a vertical plane consists of one long tangent about 1100 feet in length, running from the dam to the surge tank at the constant elevation of 640, and under a head of 35 feet. The drop in about 400 feet from the tank to the power house, is 90 feet from center line of pipe to center line of turbines, making a total head of 125 feet at the turbine.

Horizontally, there is a tangent 300 feet long running from the dam, then at an angle of about 62° another tangent 800 feet long to center line of tank. An expansion joint is provided fifteen feet from the end of first section; the end of the curve on first section being covered sufficiently deep to do away with expansion and contraction. The upper end of the first section has a fixed connection with the dam, and the lower end of the second section is rigidly connected to the tank.

At the expansion joint the shell of the adjacent pipe sections are increased from inches to inches; one pipe enters the other for not more than 30 inches, the rivets in the engaged section being counter-sunk. Between the inner pipe, and a sleeve 12 x inches, which project beyond the outer pipe, a packing such as hemp will be used, and secured by small plates riveted or bolted to the flange of the sleeve. Similar joints are provided for by elbows in the smaller pipes leading from the tank to the power house.

The alignment of the ripe in a vertical plana consists of one long tangent about 1100 feet in length, running from the came to the surge tank at the constant elevation of 60, and under a head of 35 feet. The drop in about 400 feet from the tank to the power house, is 50 feet from center line of type to center line of turbines, making a total head of 125 feet at the turbine.

Horizontally, there is a tangent 300 feet long running from the dam, then at an angle of about 62° mother tangent 800 feet long to center line of tank. An expansion joint is provided fifteen feet from the end of first section; the end of the curve on first section being covered sufficiently deep to do away with expansion and contraction. The upper end of the lover end of the second section is rigidly connected to the lower end of the second section is rigidly connected to the tank.

At the expansion joint the shell of the adjacent pipe of the expansion to the shell of the adjacent pipe anters the other for not more than 30 inches, the rivet. In the engaged section being counter-sunk. Setween the inner pipe, and a sleeve 12 x 1/2 inches, which preject beyond the cuter pipe, a packing such as hear will be used, and scoured by small places riveted or holted to the flange of the sleeve.

Similar joints are provided for by chees in the smaller pipes in; from the fack to the newer house.

### - SURGE TANK:

The surge tank is used to take up water hammer occurring when the turbines are shut off, and saving the pipe, which might be bursted. The surge tank will be built 15 feet above crest of the dam, making the elevation of top of tank 690.

The tank was designed in three sections as follows:

Let w = weight of cubic foot of water = 62.5

h = height of section to be designed

d = diameter

As= area of steel

f = unit stress allowable = 16000

Therefore, for the first section (twenty-three feet)

 $62.5 \times 58 \times 20 = A_5 \times 16000$ 

Ac= 4.5 square inches

 $A_5=.358=\frac{5}{16}$  inches

Allowing for water hammer, make plate \( \sigma\_{inch} \) thick. Second section (twenty feet)

62.5 x 35 x 20 = A<sub>s</sub> x 16000

$$A_s = 2.73 \text{ sq.ins}$$
  $\therefore t = \frac{2.73}{12} = .23 = \frac{1}{4}$ 

Allow  $\frac{3}{6}$  inches for water hammer, plate will be  $\frac{7}{6}$  inches thick.

Third section (fifteen feet)

 $62.5 \times 15 \times 20 = A_S \times 16000$ 

$$A_s = 1.17 \text{ sq.in.}$$
 :  $t = \frac{1.17}{12} = .093"$ 

For stiffness and safety, the thickness of this section will be made  $^3\!/g$  of an inch.

The surge tank is used to take up water hemaer occurring then the turbines are dut off, and 'saving the pipe, which sight be bursted. The surge task will be built 15 feet above crest of the dam, waking the slevation of top of tank 000.

The tank was designed in three sections as Tellows:

Let a - weight of cubic foot or water - th. i

h. hright of rection to be designed

referenth -b

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62.5 m 38 m 20 = A, m 16000

A= 4.5 square inches

A. 383 - 4 inches

Allowing for water hammer, make place has thick. Second section (twenty feet)

32.5 x 35 x 20 \* 4. x 16000

A. S. The equipment of the principle of the stage

Allew  $\frac{2}{2}$  inches for water harmon, juste will be  $\frac{1}{2}$  inches thick.

Third acction (fifteen feet)

8%, 5 x 18 x 10 Ac x 10000

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For stiffness and nafety, the chickness of this section will be made  $\theta_X$  of an inch.

Rivets for tank:

for tank: 
$$\frac{5}{4} \times \frac{1}{2} = \frac{5}{8}$$
;  $\frac{5}{8} + \frac{3}{16} = \frac{13}{16}$  .: use  $\frac{7}{8}$  rivets.

The spacing should be not less than

$$\frac{3}{2} \times \frac{7}{8} = \frac{21}{6} + \frac{8}{16} = \frac{29}{16} = 2 \text{ inches. (approx.)}$$

The stress at the bottom must be equal for every seam, then 62.5 x 55 x 20 = 68750 lbs. The allowable stress on each rivet is 7500 lbs. per square inch. Then  $\frac{68750}{7500}$  9; therefore 10 rivets are required. The girth seams are riveted two inches to make a water-tight connection.

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should be not less than  $\mathcal{Z}_{2} \times \mathcal{Z}_{3} = \mathcal{Z}_{3} \times \mathcal{Z}_{4} + \mathcal{Z}_{4} \times \mathcal{Z}_{5} = \mathcal{Z}_{5} \times \mathrm{char} + \mathrm{cappecs}$ 

#### POWER-HOUSE.

The power-house will be placed on the present site of an old grist mill, located on the north bank of the stream at a distance of about fifteen hundred and fifty feet from the site of the dam. The power-house will be built of concrete both substructure and superstructure. Its outside dimensions are 103 feet 4 inches x 49 feet 4 inches. The roof trusses are of steel and supported on concrete pilasters. The covering consists of corrugated red tile roofing. A traveling crane of twenty tons capacity, operated by hand power, traverses the building, the track girders being carried by the concrete pilasters. This building contains all the hydraulic units and electrical appurtenances, offices, and machine shop. The turbine units, transformers and machine shop are placed on the first floor. The switch-board gallery is placed along the south end of the building, and the top floor is reserved for bus bars and switch cells.

The available horse-power (7200) will be developed by three horizontal shaft S. Morgan Smith turbines each fifty-four inches in diameter, with a capacity of 2400 h.p. at 360 r.p.m. Each unit carries its own exciter unit mounted on same shaft. The turbines are each direct connected to three phase alternating currect generators, having an out-put of 1800 k.w. at 360 r.p.m.

The transformers are situated on the main floor along the east side of the power-house. They receive the current

ne To ofte dansers off no broads of lib, senon-yeven off a de masta will. Local d'an the mortin bank il the atreum a hio edia edi kura fera yilli ana handakan hecalik tura a na sanadadi of the dam. The power-house will be built of charres both substructure and superstructure. Its sutside dimensions are 103 feet 4 inches a 40 feet & inches. The roof traces are to -med pairerus and supported on concepts pillasters. The current com-To share published A . publicate city ber betanggroo To state twenty tons cameity, operated by hand lower, traverses the building, the track girders being carried by the concrete vileaters. This building contains all the hydraulic units and electrical appurtenence, elfices, and machine allow. The turbine units, transformers and weching shop are placed on the first floor. The switch-board gallery is placed along the south and of the building, and the top flear is reserved for bus bars and smitch colls.

The transformers are situated on the main floor liong of the power-hause. They controll the current

from the generators, and step up the voltage to 33000 at which pressure the currect will pass into the transmission lines.

For the present, two units of twenty-four hundred h.p. each are to be installed and provision in size of pen-stocks, power-house etc. left for a third unit of twenty-four hundred h.p. to be installed latter when increased market demand shall justify same.

THE PARTY NAMED AND ADDRESS OF THE PARTY NAMED AND ADDRESS OF

Fiber stress in stock -- 10000 jourds per square ince. The formula used for bending meast was:

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where We total load on bear

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Dead lood -- 50 pounds per square fock.

n u u u con -- i.o u u u

Bending someon, M: 10 W1

COLUMN: - supporting third floor, the fellecing lending was

HIROSIAN D

Dead lead -- 50 pounds per square feet.

Live iced -- 180 " " " "

Toute INALL or Weigenreich's "Reinforced Concrete" was used

In determining the size of columns one amount of reinforcement.

In all the above calculations the allowable stresses

In the concerts were taken as:

Congression ------indicate is square inch.

" " " " Ook/Massacrame notanet at loot?

Weight of concrete ..... cutte for



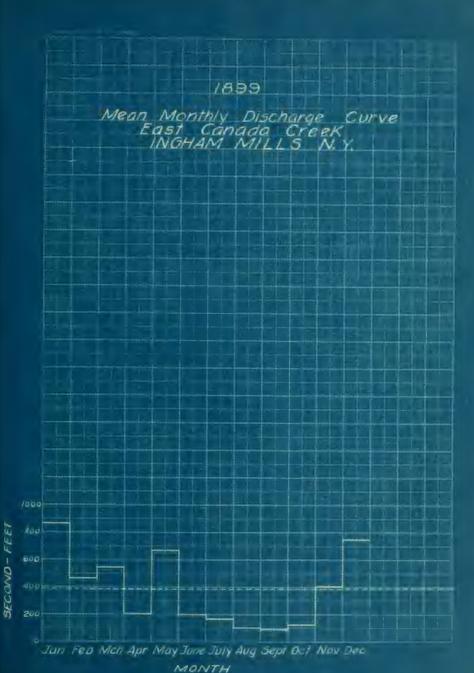
Drainage Area of East Canada Creek Shaded

PROPOSED EAST CREEK DEVELOPMENT INGHAM MILLS IMMEDIATE VICINITY G NBuck IN J Newsuy, G D.J. ettermann T HE SI 5





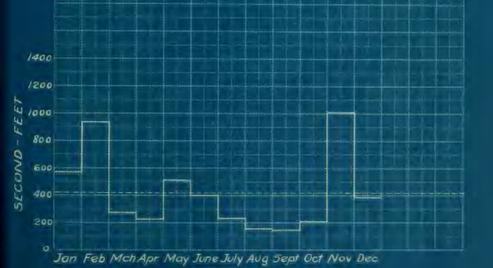






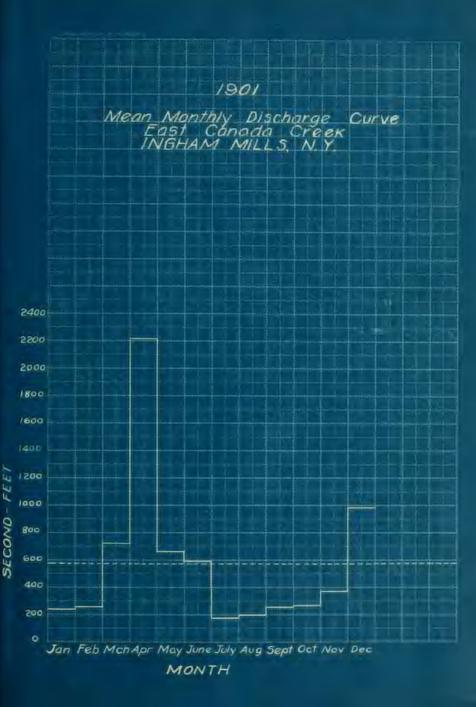


Mean Monthly Discharge Curve East Conada Creek INGHAM MILLS, NY

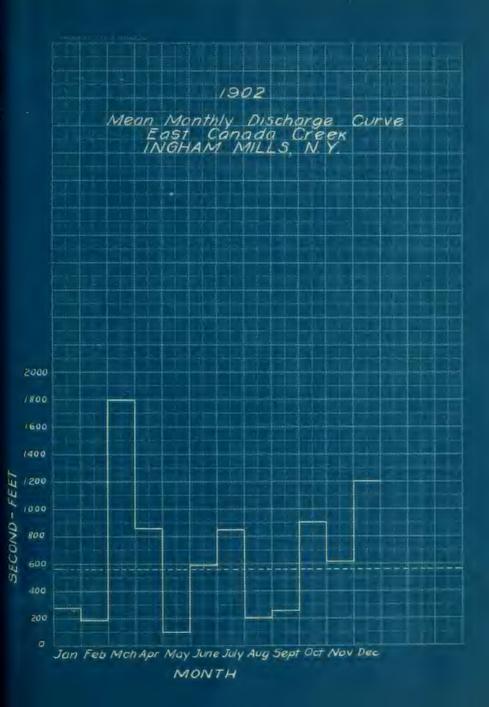


MONTH





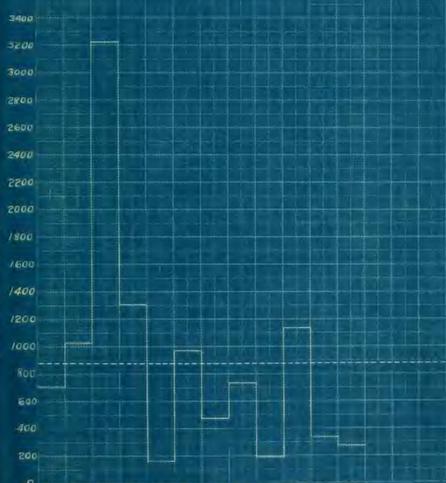








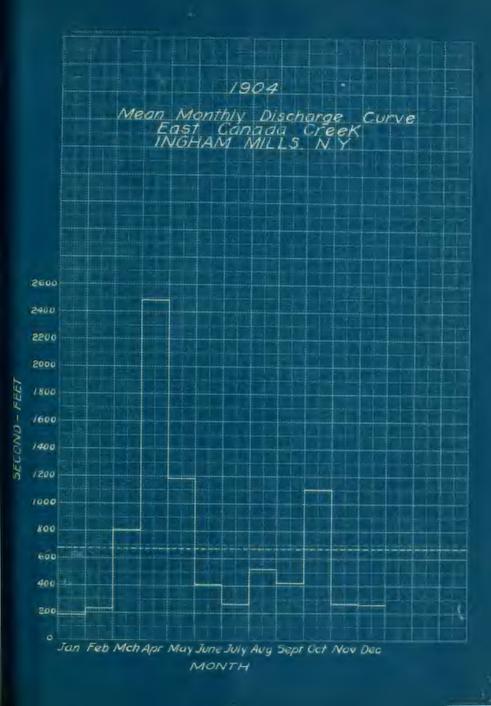
Mean Monthly Discharge Curve East Canada Creek INGHAM MILLS, N.Y.



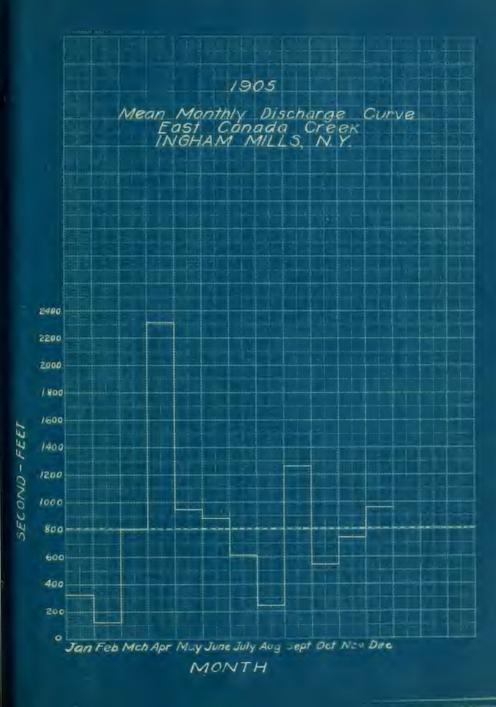
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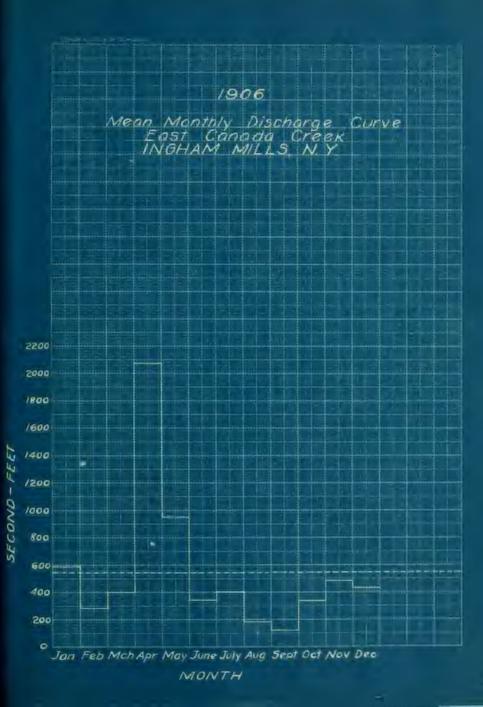




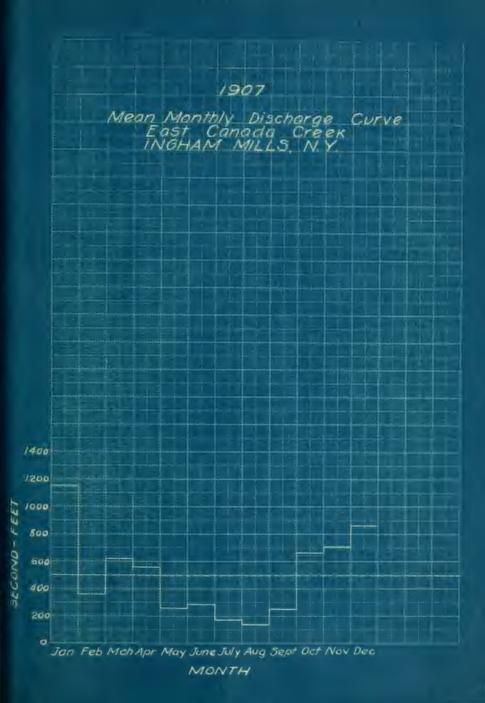




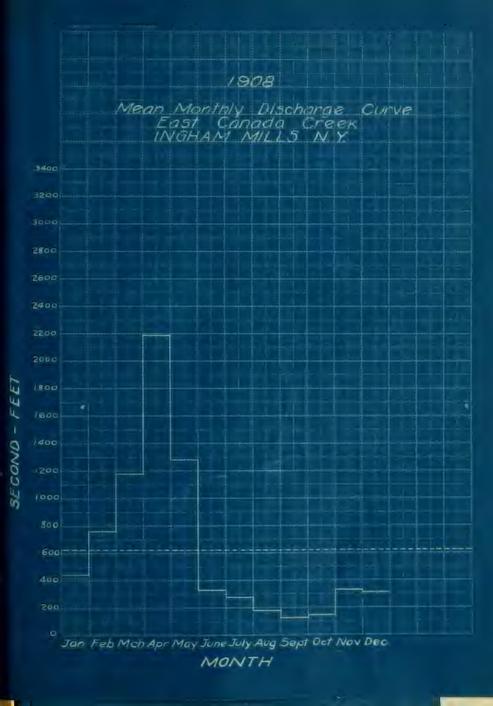




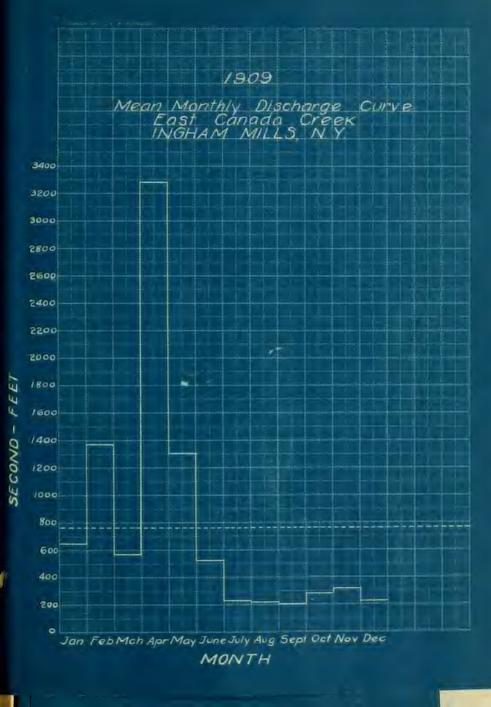


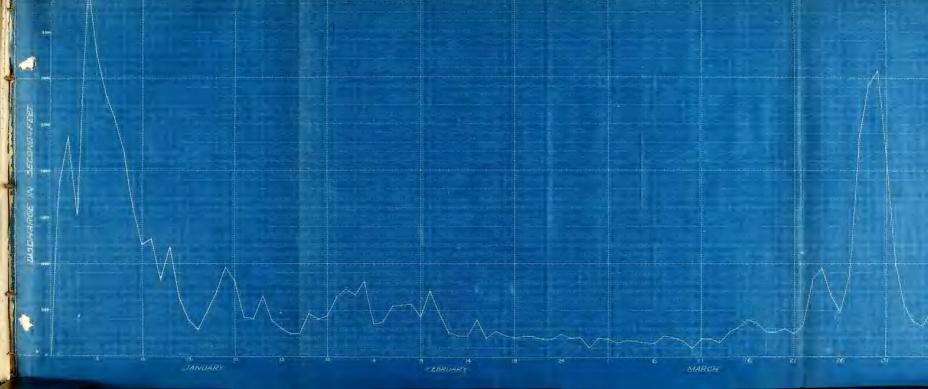


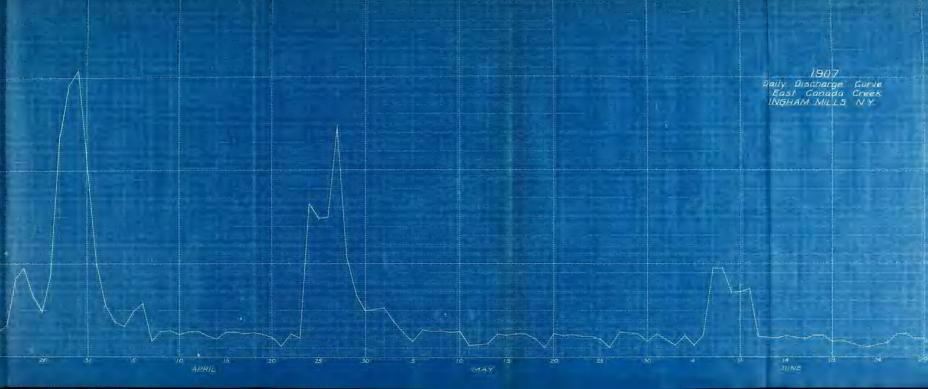


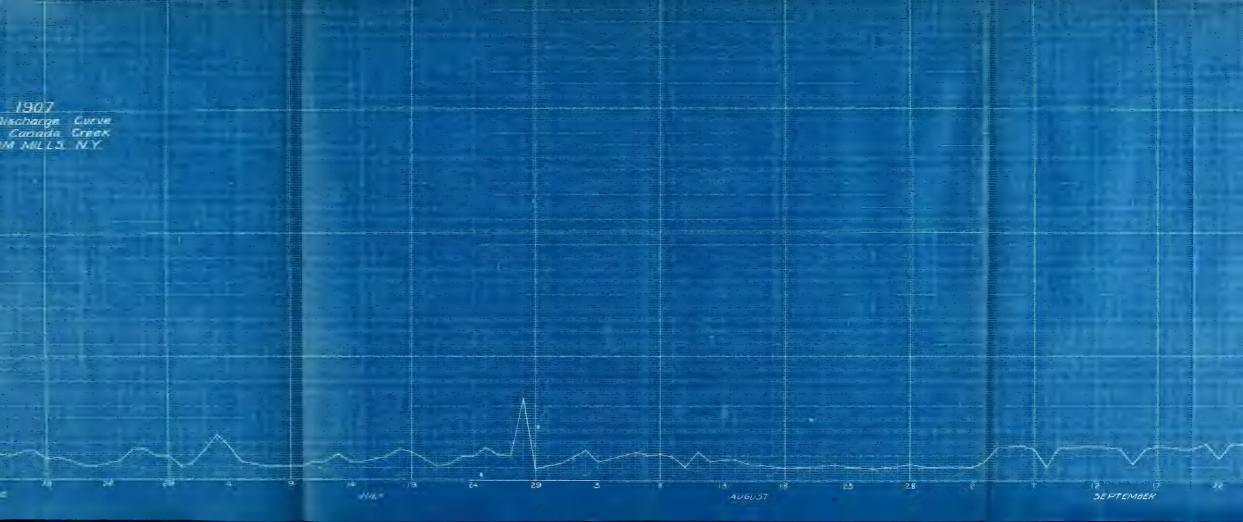


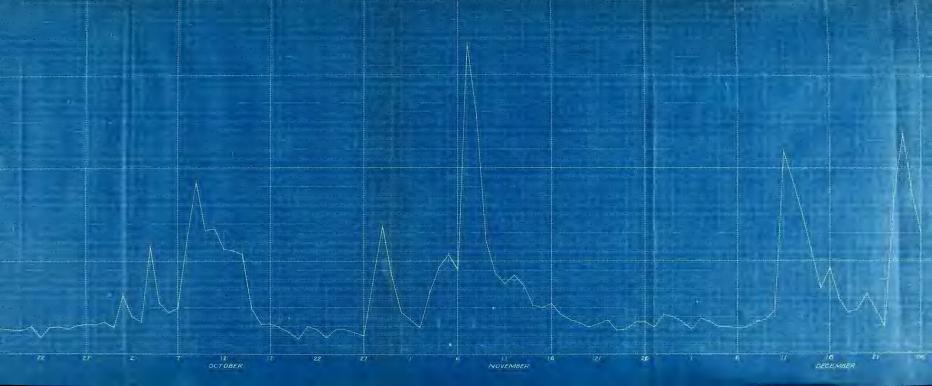




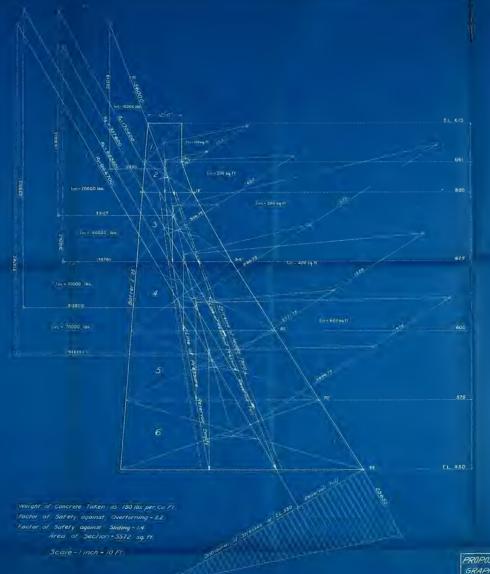




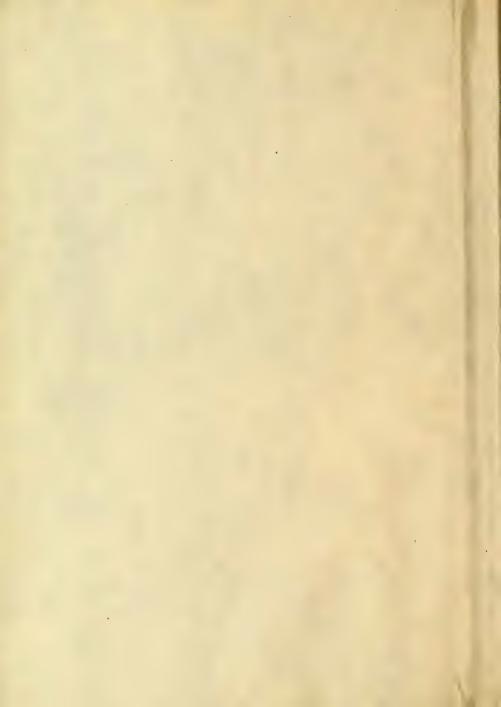


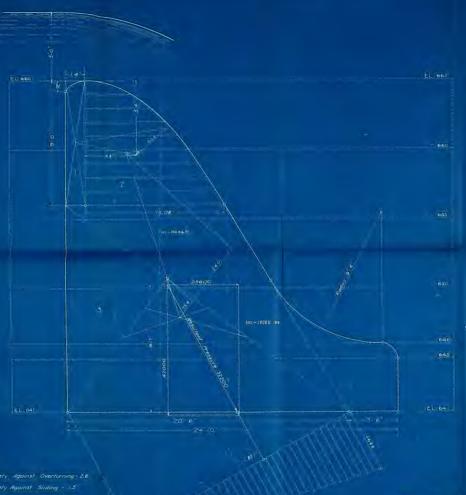






PROPOSED EAST CREEK DEVELOPMENT GRAPHIC ANALYSIS OF DAM STABILITY AND STRESSES & Millsuck, Hydicanay, B.D. Sottermann THE 515



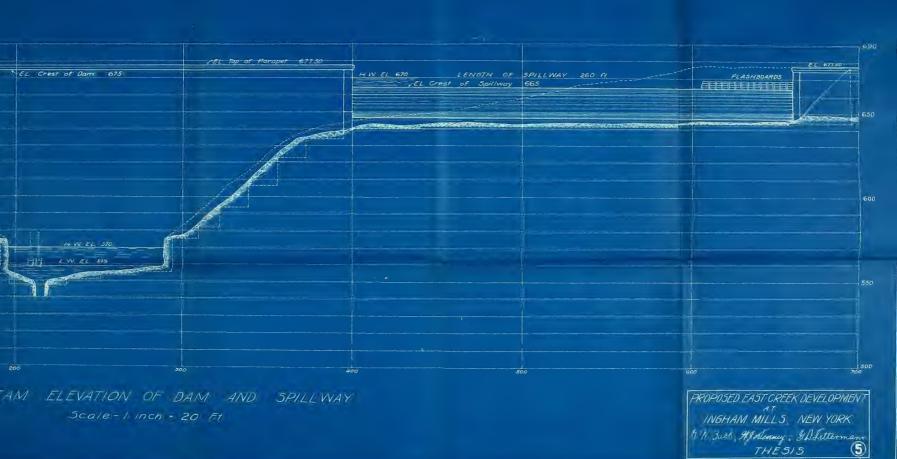


PROPOSED EAST CREEK DEVELOPMENT GRAPHIC ANALYSIS OF SPILLWAY STABILITY AND STRESSES & W. Buck Mysternag. & Dettermann THE 515



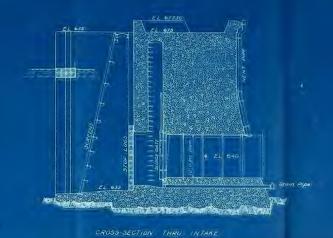
DOWN STREAM ELEVATION OF DAM AND SPILL WAY.

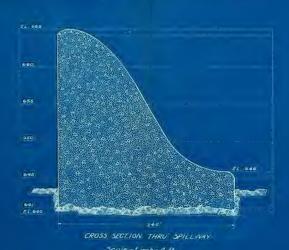
5cale - 1 inch - 20 Ft









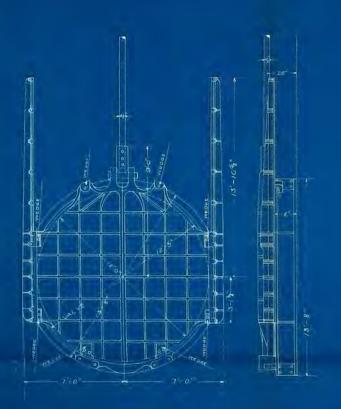


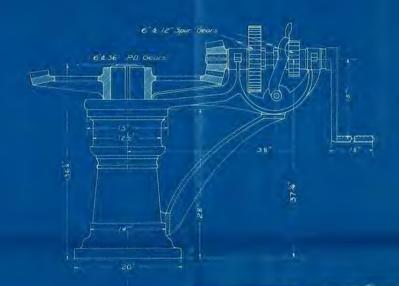




PROPOSED EAST CREEK DEVELOPMENT INBUK; Af Now y Bashettermann







Scale - It inch = I Ft.

PROPOSED EAST CREEK DEVELOPMENT

SLUICE GATE

OPERATING STAND

& W. Buck. Affairing & D. Lettermann
THE 515



